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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

TIMOTHY P. WEIHS ET AL.

Application No.: 10/247,998

Filed: September 20, 2002

For: METHODS OF MAKING AND USING FREESTANDING REACTIVE MULTILAYER FOILS

Examiner: Robert R. Koehler

Group Art Unit: 1775

November 1, 2004

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Sir:

Prior to examination on the merits, please amend the above-identified application (the "Application") as follows.

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office, Fax No. 703-872-9306 on

November 1, 2004
Date of Deposit

DANIEL D. SIERCHIO Reg # 53,591
Name

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Signature

November 1, 2004
Date of Signature

AMENDMENTS TO THE CLAIMS:

Please cancel Claims 34-36 of the above-captioned application as shown below.

1. (Original) A method of making a freestanding reactive multilayer foil composed of a plurality of alternating layers that can react exothermically, comprising the steps of:

providing a substrate;

vapor depositing the alternating layers on the substrate to form the reactive multilayer foil; and

separating the multilayer foil from the substrate.

2. (Original) The method of claim 1 wherein the substrate has sufficient adherence to the deposited layers to retain the layers during deposition but insufficient adherence to prevent removal of the multilayer foil after deposition.

3. (Original) The method of claim 1 wherein the layers comprise one or more layers of aluminum, and at least one of the layers of aluminum is deposited in contact with the substrate .

4. (Original) The method of claim 3 wherein the substrate comprises silicon.

5. (Original) The method of claim 1 wherein the substrate comprises a coating of a release material or a coating of an adhesion material.

6. (Original) The method of claim 1 wherein the substrate comprises a removable sacrificial layer.

7. (Original) The method of claim 1 wherein the substrate comprises a removable sacrificial layer of copper, brass or photoresist.

8. (Original) The method of claim 1 wherein the vapor depositing comprises physical vapor deposition.

9. (Original) The method of claim 1 wherein the vapor depositing comprises magnetron sputtering or electron beam evaporation.

10. (Original) The method of claim 1 wherein the substrate is cooled during the vapor depositing.

11. (Original) The method of claim 1 wherein the layers are deposited to form a multilayer foil having a thickness in the range 50μm-1cm.

12. (Original) The method of claim 1 wherein the vapor depositing is under conditions chosen to minimize stress in the deposited layers.

13. (Original) A method of bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a freestanding reactive multilayer foil;

pressing the bodies together against the foil; and

igniting the reactive foil.

14. (Original) The method of claim 13 wherein at least one of the bodies is a semiconductor or microelectronic device.

15. (Original) The method of claim 13 wherein the reactive multilayer foil has a thickness in excess of 10μm.

16. (Original) The method of claim 13 wherein the bodies have coefficients of thermal expansion differing by at least 1 μm/m/°C.

17. (Original) The method of claim 13 wherein the first body comprises metal and the second body comprises ceramic material.

18. (Original) The method of claim 13 wherein at least one of the two bodies comprises a metallic glass.

19. (Original) The product made by the method of claim 13.

20. (Original) A reactive multilayer foil comprising:

a foil composed of alternating layers that react exothermically , wherein the foil includes a plurality of openings through the foil.

21. (Original) A reactive multilayer foil according to claim 20 wherein the openings are filled with joining material, propellant, or material that changes or reacts on heating.

22. (Original) A reactive multilayer foil according to claim 20 wherein the openings are periodically arranged across the area of the foil.

23. (Original) A method of making a reactive multilayer foil comprising the steps of:

providing a substrate having a surface including a plurality of preformed openings, bumps, or particles of thickness or depth similar to or greater than the multilayer foil to be deposited;

depositing on the surface a plurality of layers to form the reactive multilayer foil; and

separating the multilayer foil from the substrate.

24. (Original) A method of making a reactive multilayer foil comprising the steps of:

providing a flat substrate;

depositing on the substrate a plurality of layers to form a reactive multilayer foil;

depositing a masking layer on top of the reactive foil;

patterning the masking layer with a plurality of holes;

etching the reactive foil through the holes; and

separating the multilayer foil from the substrate.

25. (Original) A method of making a reactive multilayer foil comprising the steps of:

providing a flat substrate;

depositing on the substrate a plurality of layers to form a reactive multilayer foil; and

mechanically pressing a plurality of holes into the reactive foil.

26. (Original) A method of making a reactive multilayer foil comprising the steps of:

making a reactive multilayer foil having a plurality of openings through the foil, and

filling the openings in the multilayer foil with joining material, propellant, or material that will change or react on heating when the reactive foil is ignited.

27. (Original) A method of bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a reactive multilayer foil and at least one joining material, the reactive multilayer foil having a plurality of openings through the thickness of the foil;

pressing the bodies together against the foil and the joining material; and

igniting the reactive foil to heat the joining material and permit the melted or softened joining material to flow through the openings to join the first and second bodies.

28. (Original) The method of claim 27 wherein at least one of first body or the second body comprise a semiconductor or a microelectronic device.

29. (Original) The method of claim 27 wherein the first body and the second body have CTEs that differ by more than about 1μm/m/°C.

30. (Original) The method of claim 27 wherein at least one of the two bodies comprises a metallic glass.

31. (Original) The product made by the method of claim 27.

32. (Original) The product made by the method of claim 28.

33. (Original) The product made by the method of claim 29.

34-36. (Cancelled)

37. (Original) A method of connecting a semiconductor or microelectronic device having one or more electrical contacts to a substrate having one or more receiving contacts, comprising the steps of:

disposing between the device and the substrate a reactive multilayer foil composed of one or more first regions that can react exothermically to form electrically conductive regions and one or more second regions which are non-conductive or react to form non-conductive material.;

registering the contacts of the device, the contacts of the substrate and the first regions of the foil,

pressing the device and the substrate together against the foil; and

igniting the foil.

38. (Original) A method for bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a reactive multilayer foil comprising a plurality of successive exothermic reactive layers that react to form a joining material;

pressing the bodies together against the foil; and

igniting the foil.

39. (Original) The method of claim 38 wherein at least one of the first and second bodies comprise metallic glass.

40. (Original) The method of claim 38 wherein the reactive multilayer foil comprises alternate layers of alloys that, after reaction and cooling, comprise amorphous material.

41. (Original) The method of claim 38 wherein the reactive multilayer foil comprises alternate layers that, after reaction and cooling, are fully or partially quasicrystalline.

42. (Original) The method of claim 38 wherein the reactive multilayer foil comprises alternate layers of an alloy comprising Ni or Cu, an alloy comprising Ti, Zr, or Hf, and an alloy containing Al.

43. (Original) A method of bonding a first body to a second comprising the steps of:

disposing between the first body and the second body, a freestanding reactive multilayer foil and at least one layer of joining material;

pressing the bodies together against the foil and joining material; and

igniting the reactive foil to melt or soften the joining material.

44. (Original) The method of claim 43 wherein the joining material is coated on the foil.

45. (Original) The method of claim 43 wherein the joining material is freestanding.

46. (Original) The method of claim 43 wherein the joining material comprises a metallic glass.

47. (Original) A bonded structure comprising:

a first body;

a second body bonded to the first body by a joining region, the joining region comprising a reacted multilayer structure including a periodic array of openings therethrough, the structure embedded in a matrix of joining material extending through the openings to join the first body and the second body.

48. (Original) A method of bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a reactive multilayer foil and at least one layer of joining material;

pressing the bodies together against the layer of joining material and the foil; and

igniting the reactive foil to melt or soften the joining material.

49. (Original) The method of claim 48 wherein the reactive multilayer foil has a plurality of openings through the thickness of the foil to permit the heated joining material to flow through the foil.

50. (Original) The method of claim 48 wherein the reactive multilayer foil forms cracks through the foil after ignition to permit the heated joining material to flow through the foil.

51. (Original) The method of claim 48 wherein the reactive multilayer foil has scoring or a plurality of openings to facilitate cracking after ignition.

52. (Original) The method of claim 48 further including the step of placing the foil under tensile force to facilitate cracking of the foil and extrusion out of the joint interface after ignition.

53. (Original) The method of claim 48 further including the steps of pressing the two bodies together against the joining material and the foil with sufficient pressure to extrude a portion of the foil reaction products from between the bodies after ignition.

54. (Original) The method of claim 48 wherein the joining material when heated by the reactive foil has sufficient viscosity to facilitate extrusion of foil reaction products from between the bodies after ignition.

55. (Original) The method of claim 48 wherein the layer of joining material includes dispersed particles to increase the viscosity of the material when molten.

56. (Original) The method of claim 48 further including the step of preheating the joining material prior to igniting the reactive foil.

57. (Original) The method of claim 48 wherein the joining material is heated and cooled with sufficient rapidity to form an amorphous material.

58. (Original) The method of claim 48 wherein the joining material comprises an amorphous material.

59. (Original) The method of claim 58 wherein the first and second bodies are pressed against the joining material and foil with a pressure greater than about 10 MPA.

60. (Original) The method of claim 58 wherein the reactive foil has thickness in excess of about 100 micrometers.

61. (Original) The method of claim 58 wherein the reactive foil generates an energy density greater than about 70 $J/cm^2$.

62. (Original) A layered structure for bonding together two bodies comprising a reactive multilayer foil and a layer of joining material.

63. (Original) The structure of claim 62 wherein the reactive multilayer foil is scored or perforated to facilitate cracking after ignition.

64. (Original) The structure of claim 62 wherein the reactive multilayer foil has a plurality of openings for the passage of the joining material after heating.

65. (Original) The structure of claim 62 wherein the joining material comprises an amorphous material.

66. (Original) The structure of claim 62 wherein the joining material comprises a metallic glass.

67. (Original) The structure of claim 62 wherein the joining material comprises a crystalline metallic material that cools to a material comprising amorphous material after heating by ignition of the reactive foil.

68. (Original) The structure of claim 62 wherein the joining material comprises a crystalline metallic material that cools to a fully or partially quasicrystalline state after heating by the reactive foil.

## REMARKS

Please cancel Claims 34-36 of the Application. This Application is co-pending with the following related applications: U.S. Patent Application Serial Number 10/761,440 and U.S. Patent Application Serial Number 10/761,439. Claims 34-36 have been cancelled to avoid any arguable double patenting with the claims of U.S. Patent Application Serial Number 10/761,440 and U.S. Patent Application Serial Number 10/761,439.

No fee is required for entry of this amendment. If any fee is due, however, please charge the required fee to deposit account number **501358**. Applicants' undersigned attorney may be reached by telephone at (973) 597-2500. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,

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